S/N 10/668,753 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	McArdle et al.	Examiner:	M. Marcheschi
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By: ______________________
Name: DAVID ORTIZ

DECLARATION OF JAMES L. McARDLE

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

1. My name is James L. McArdle, a named inventor on this patent application.

2. I hold a Doctorate in Ceramic Science from Penn State University, which was awarded to me in 1989.

3. I am currently employed by 3M Company in the position of Senior Product Development Specialist, in the Abrasive Systems Division. I have been at 3M since 1990 and in the Abrasive Systems Division since approximately 1996. Prior to my position with Abrasive Systems Division, I was in the Ceramic Fibers Laboratory, developing ceramic fibers, and prior to that in a Corporate Sector Laboratory, conducting research on aluminum oxide ceramic materials.

4. As a Senior Product Development Specialist in the Abrasive Systems Division, I develop new constructions of abrasive articles and modify existing products. I evaluate and experiment with different abrasive particles (including their type and size) in different binder systems. For structured abrasive articles, I also evaluate and experiment with different composite topographies, including shapes and sizes, and which abrasive coatings are best for which topography.

5. Also as a Senior Product Development Specialist in the Abrasive Systems Division, I test (internally at 3M facilities) abrasive articles developed by myself and by others; this testing includes my operating of various hand-held and free-standing grinding machines. I evaluate which abrasive constructions work best in which applications, and modify abrasive constructions as needed.

6. I visit current 3M customers, potential 3M customers, and past 3M customers and conduct field trials with experimental and commercially-available abrasive products in order to validate abrasive product designs and to correlate internal test procedures and test results against customers' grinding processes. I recommend abrasive articles for customers' specific needs.

7. As stated above, I am a named inventor on this application. Together with my co-inventor, Scott Culler, I determined that a structured abrasive article, having a composite height of greater than 500 micrometers and utilizing ceramic abrasive particles having a size of at least 85 micrometers, provided abrasive cutting results that were unexpected based on my prior experiences.

8. In the Examples section of this patent application, serial no. 10/668,753 filed September 23, 2003, several abrasive article examples and comparative examples were presented. Some of these are presented again below.

9. Since the filing of the patent application, Scott Culler and I have prepared five additional abrasive article examples that have a composite height of greater than 500 micrometers and utilize ceramic abrasive particles having a size of at least 85 micrometers, and comparative examples. These are presented below as Examples D1, D2, D3, D4 and D5.

10. The following Tables 1 and 2 provide the characteristics and formulations for several of the original examples from the application and the new examples, Examples D1, D2, D3, D4 and D5.

Table 1

Example	Mineral	Mineral Type	Approx. mineral size µm	Tooling feature type	Composite Height µm
3	80 CAO	ceramic	300	#7 CK	610
4	80 FAO	fused	300	#7 CK	610
10	80 CAO	ceramic	300	040 SQRT	1016
11	80 FAO	fused	300	040 SQRT	1016
14	P600 FAO	fused	30	030 SQRT	762
15	JIS400 CAO	ceramic	30	030 SQRT	762
D1	JIS400 CAO	ceramic	30	#7 CK	610
D2	JIS400 CAO	ceramic	30	040 SQRT	1016
D3	80 CAO	ceramic	300	#7 CK	610
D4	80 CAO	ceramic	300	14 CK MVP	356
D5	80 FAO	fused	300	#7 CK	610

The mineral, mineral type, and tooling feature definitions were provided in the patent application.

The "14 CK MVP" composite topography was one with a rectangular pyramid base having a base width range of 0.016-0.018 inch (406-711 micrometers) with an average base with of 0.023 inch (584 micrometers), pyramid height of 0.014 inch (356 micrometers) and a linear pyramid edge profile. This topography is described in U.S. Patent No. 6,076,248 at column 15, lines 8-32. Examples 1, 1A and 2 of the '248 patent had this topography. This same topography is used for an abrasive article commercially available from 3M Company under the designation "253FA".

Table 2

Example	TMPTA	PH2	KBF4	CaSi	ASF	FGP	SCA	Mineral
3	1168	11.6	964			964	19	2894
4	1168	11.6	964			964	19	2894
10	612	6.2		800	30		30	1300
11	612	6.2		800	30		30	1300
14	772	8		700	14		30	950
15	772	8		700	14		30	950
D1	772	8		700	14		30	950
D2	772	8		700	14		30	950
D3	612	6.2		800	30		30	1300
D4	612	6.2		800	30		30	1300
D5	612	6.2		800	30		30	1300

11. From the above-provided examples, the following direct comparisons can be made:

Ex. 3 vs. Ex 4: ceramic vs. non-ceramic mineral, with same size mineral in same composite;

Ex. 10 vs. Ex 11: ceramic vs. non-ceramic mineral, with same size mineral in same composite;

Ex. 14 vs. Ex 15: ceramic vs. non-ceramic mineral, with same size mineral in same composite;

Ex. D3 vs. Ex. D5: ceramic vs. non-ceramic mineral, with same size mineral in same composite;

Ex. D3 vs. Ex. D4: large composite vs. small composite, with same ceramic mineral;

Ex. 10 vs. Ex. D3: very large composite vs. large composite, with same ceramic mineral;

Ex. D2 vs. Ex. D1: very large composite vs. large composite, with same ceramic mineral;

Ex. D3 vs. Ex. D1: large mineral particles vs. small mineral particles, with ceramic mineral in same composite;

Ex. 10 vs. Ex. D2: large mineral particles vs. small mineral particles, with ceramic mineral in same composite.

12. Table 3 provides grinding test results for Examples 3-4, 10-11 and 14-15 from the application and the new examples, Examples D1, D2, D3, D4 and D5. Examples D1, D2, D3, D4 and D5 were tested by Test Procedure III outline in the application, as were Examples 10-11 and 14-15. Examples 3 and 4 were tested by Test Procedure II, also outlined in the application.

Table 3

Example	Initial cut, g/cycle	Final cut, g/cycle	Δ%, initial v. final	Initial Ra, μin	Final Ra, μin	Total Cycles	Total cut, g
3	429	228	46.8			12	3680
4	303	176	41.9			12	2653
10	93.6	82.0	12.4	168	111	60	5380
11	73.0	54.4	25.5	100	74	60	3720
14	17.2	5.0	70.9	15	7	35	392
15	23.8	11.2	52.9	28	12	35	641
D1	21.4	2.8	86.9	33.7	8.4	60	751
D2	20.6	12.8	37.9	36.4	16.6	60	1044
D3	67.4	55.4	17.8	161.3	115.7	60	3918
D4	68	51.2	24.7	142.7	90.8	60	3729
D5	53	29.4	44.5	130.3	74	60	2375

13. By comparing Example 3 (ceramic) with Example 4 (fused), one can see that having a ceramic abrasive particle in the same composite topography provides much better grinding performance, total cut being 3680 g compared to 2653 g. The rate of cutting, at the final cycle, was 228 g compared to 176 g; Example 3 had more life remaining. This is also seen in other examples. When Example 10 (ceramic) is compared to Example 11 (fused), total cut was 5380 g compared to 3720 g, and the rate of cutting at the final cycle was 82 g compared to 54.4 g. When Example 15 (ceramic) is compared to Example 14 (fused), total cut was 641 g compared to 392 g, and rate of cutting at the final cycle was 11.2 g compared to 5 g. When Example D3 (ceramic) is compared to Example D5 (fused), the total cut was 3918 g compared to 2375 g and the rate of cutting at the final cycle was 55.4 g to 29.4 g.

14. By comparing Example D3 (large composite, 610 μm) with Example D4 (small composite, 356 μm), one can see that having the large composite in the same abrasive formulation provides better grinding performance, total cut was 3918 g compared to 3729 g and the rate of cutting at the final cycle was 55.4 g compared to 51.2 g. From my grinding experience and from working with customers, a difference in total cut of 189 g, even though only about 5% difference, is significant as to which product is preferred. Also from my experience, a difference in cut rate of 4.2 g/cycle, even though only about 8% difference, is significant as to which product is preferred. This better grinding performance is also seen within the desired topography

(i.e., greater than 500 micrometers), when Example 10 (very large composite, 1016 μm) is compared to Example D3 (large composite, 610 μm), total cut was 5380 g compared to 3918 g, and the rate of cutting at the final cycle was 82 g compared to 55.4 g. When Example D2 (very large composite 1016μm) is compared to Example D1 (large composite, 610 μm), total cut was 1044 g compared to 751 g, and the rate of cutting at the final cycle was 12.8 g compared to 2.8 g.

15. By comparing Example D3 (large particle size, 300 μm) with Example D1 (small particle size, 30 μm), one can see that having a larger ceramic abrasive particle in the same formulation and topography provides better grinding performance, the total cut was 3918 g compared to 641 g and the rate of cutting at the final cycle was 55.4 g compared to 2.8 g. This is also seen when Example 10 (large particle size, 300 μm) is compared to Example D2 (small particle size, 30 μm), total cut was 5380 g compared to 1044 g, and the rate of cutting at the final cycle was 82 g compared to 12.8 g.

16. The results above show that the combination of the three claimed features, which provide an abrasive article having ceramic abrasive particles with a size of at least 85 micrometers in composites having a height of greater than 500 micrometers, provides abrasive cutting results which were unexpected. This combination of the three features provides an abrasive article that does not experience the usual decrease in cut rate performance over time, as is seen by abrasive articles not having this combination of three features. The abrasive articles having the three features provide a greater total cut than abrasive articles not having this combination of features. This combination of the three features also provides an abrasive article that has a faster instantaneous cut rate after a set number of cycles, thus also resulting in a greater total cut. Additionally, this combination of the three features provides an abrasive article that has a more consistent cut rate, over the life of the abrasive article, as compared to abrasive articles not having the combination of three features.

17. One cannot assume that the same abrasive particle in the same formulation will perform better in larger topography. Inappropriate selection of the abrasive composite formulation and the topography may prevent the gradual breakdown or wear of the composite, which is needed to

expose active abrasive particles at lower heights in the composite structure. Abrasive particles held too firmly against applied grinding pressure results in development of wear flats on, or "dulling" of exposed abrasive particles, thus reducing the abrasive cut performance, and causing a rapid decline in the abrasive cut rate. A larger topography increases the area available for cutting, which results in lower pressure per area, which may also prevent the gradual breakdown or wear of the composite.

18. One cannot assume that a larger abrasive particle will perform better than a smaller abrasive particle in the same formulation and same topography. Fewer numbers of large abrasive particles can fit into the space or volume of a small topography, limiting the number of large abrasive particles present in the composite. This also limits the number of abrasive particles available for exposure to a workpiece. Furthermore, inappropriate selection of the abrasive composite formulation may prevent retention of abrasive particles in the composite structure against applied grinding pressures. The composite may wear away rapidly, reducing the useful life of the abrasive and causing a rapid decline in the abrasive cut rate.

19. I have determined, in combination with my named co-inventor Scott Culler, that the combination of large (i.e., at least 85 micrometer) ceramic abrasive particles in a large topography (i.e., at least 500 micrometers) composite provides improved and consistent cut performance over time, as compared to an abrasive article not having each of these three features.

20. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under *§ 1001* of Title XVIII of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: 3-23-05

James L. McArdle